Available online at www.sciencedirect.com
SCIENCE DIRECT®
Forensic Science International 144 (2004) 243–245
Forensic Science International
www.elsevier.com/locate/forsciint

Forensic age diagnostics of living people undergoing criminal proceedings

A. Schmeling[a,*], A. Olze[a], W. Reisinger[b], G. Geserick[a]

[a]Institute of Legal Medicine, Charité—Universitätsmedizin Berlin, Hannoversche Str. 6, D-10115 Berlin, Germany
[b]Institute of Radiology, Charité—Universitätsmedizin Berlin, Schumannstr. 20/21, D-10117 Berlin, Germany

Available online 7 June 2004

Abstract

In the German-speaking area, recent years have seen a rapid growth of the need for forensic age estimations. Such need arises, for example, if no verified information on the age of a person suspected of a criminal offence is available; the issue at question in terms of criminal law is whether the person concerned has reached the age of criminal responsibility and whether general criminal law in force for adults is to be applied. The relevant age tresholds in criminal proceedings are 14, 18 and 21 years of age.

According to recommendations of the Study Group on Forensic Age Diagnostics, a forensic age estimate should consist of a physical examination, an X-ray of the hand, and a dental examination which records dentition status and evaluates an orthopantomogram. In addition, a radiological or CT examination of the clavicles is recommended to establish whether a person has attained 21 years of age.

The present article addresses the influence of ethnic origin on the examined developmental systems.

Keywords: Forensic age estimation; Sexual maturation; Hand ossification; Dentition; Clavicle ossification

1. Introduction

As a result of the rise of cross-border migration in recent years, many European countries have seen an increase in the number of foreigners who cannot provide documentary evidence for their date of birth. Because of this development, determination of a person's age has become an integral part of forensic practice. The number of age diagnoses made every year in the German-speaking area soared from 185 in 1996 to approximately 500 at present [14]. The persons under examination are foreigners without valid identification documents who are suspected of making false statements about their age and whose genuine age is relevant in criminal proceedings for deciding whether they have reached the age of criminal responsibility and whether general criminal law in force for adults is to be applied. German criminal law defines three age thresholds: 14, 18 and 21 years [6].

The Xth Lübeck Meeting of German Forensic Physicians in December 1999 provided the opportunity for a first transregional analysis of the current state of forensic science with respect to the determination of a person's age. The conference proposed that a study group composed of forensic physicians, dentists, radiologists, and anthropologists should be set up to develop guidelines for issuing expert opinions in order to standardize the as yet rather heterogeneous procedure and to implement quality assurance policies in this area. The interdisciplinary Study Group on Forensic Age Diagnostics (http://www.charite.de/rechtsmedizin/agfad/index.htm) was constituted in Berlin in March 2000 and currently comprises 76 members from the German-speaking countries, from Belgium, France, Norway, Spain and the United States of America. This Study Group has drawn up guidelines for carrying out age estimates on living individuals for the purpose of criminal proceedings [13]. With a view to quality assurance, the Study Group on Forensic Age Diagnostics organizes annual ring experiments; participants will receive a certificate issued by the Board of the Study Group.

* Corresponding author. Tel.: +49 30 450525050; fax: +49 30 450525903.
E-mail address: andreas.schmeling@charite.de (A. Schmeling).

0379-0738/$ – see front matter © 2004 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.forsciint.2004.04.059

2. Methods

According to the recommendations of the Study Group on Forensic Age Diagnostics, age estimates carried out for the purpose of criminal proceedings should consist of a physical examination which also records anthropometric data, signs of sexual maturation as well as potential age-relevant developmental disorders, an X-ray of the left hand, and a dental examination which records dentition status and evaluates an orthopantomogram. In addition, a radiological or CT examination of the clavicles is recommended to establish whether the person concerned has attained 21 years of age [13]. With a view to increasing the accuracy of age estimates and to identifying age-relevant developmental disorders, a combination of the methods mentioned above should be used; it must be ensured, however, that each examination is carried out by an expert with forensic experience. The expert in charge of coordinating all examinations has to summarize the results in a final age diagnosis.

In Germany any X-ray examination that is not based on medical indication has to be authorized by a court order under Section 81a of the Code of Criminal Procedure (StPO), because under Section 25 of the X-Ray Ordinance (RöV) such examinations must be allowed for by law. There is no reason to fear that the amount of radiation a person is exposed to during the necessary X-ray examinations will have a detrimental effect on his/her health [5,12].

The physical examination determines anthropometric measures such as height and weight, constitutional type, alongside visible signs of sexual maturity. Tanner staging for sexual maturation [16] is commonly used for this purpose. Of the forensic methods recommended for age determination, sexual maturation shows the largest range of variation and therefore should be used for age determination purposes only in conjunction with the evaluation of skeletal maturity and tooth development. However, the physical examination is indispensable to rule out possible visible age-related symptoms of illness, and to check whether the results of skeletal and tooth age determination correspond with the development of the whole organism.

Hand X-rays form the second pillar of forensic age determination for the purpose of criminal proceedings. A basic prerequisite for determining a person's age by radiological means is the physical examination in order to establish whether the person has a disease that may affect skeletal development. Criteria for evaluating hand radiographs include the form and size of bone elements and the degree of ossification of epiphyseal cartilages. The X-ray image is compared with standard images of the relevant age and sex (radiographic atlas) [4,19], or the degree of skeletal maturity is determined for selected bones (single bone method) [10,17,18].

The main criteria evaluated during dental examination are the eruption and mineralization of third molars. Third molars usually erupt after completion of the 17th year of age (at least in Europoid populations) [9]. After another two to four years, the occlusal plane is reached [1]. However, significant differences between individuals must be expected, so that examination results must be dealt with carefully. Tooth mineralization is evaluated based on what is known as an orthopantomogram, an X-ray of the dentition. The classification of stages proposed by Demirjian et al. [2] lends itself best for forensic purposes, since stages are defined by changes in form and independently of speculative length estimates.

In order to answer the legally relevant question of whether a person has reached 21 years of age, it is particularly important to evaluate the progress of ossification of the cartilage at the sternal end of the clavicle, because all other examined developmental systems have completed their growth at this time. A number of studies are available, examining the ossification of the medial cartilage of the clavicle by radiological means, conventional and CT [7,8,15]. Closure of epiphyseal growth plates and visibility of epiphyseal scar indicates, in the case of women, that the person is at least 20 years old, and, in the case of men, that the person is at least 21 years old. Total fusion of epiphyses with disappearance of the epiphyseal scar was observed in both genders at the age of 26 at the earliest [15].

3. The influence of ethnicity on the examined developmental systems

The main countries and regions of origin of persons to be examined for age determination purposes in the German-speaking area are Africa, Turkey, Romania, the Balcans, Lebanon and Vietnam [3]. Since reference studies that could be used for forensic purposes are generally not available for these areas of origin, the question arises whether there are significant developmental differences between various ethnic groups which would contradict the application of relevant age standards to members of an ethnic group other than the reference population.

As far as the relevant age group is concerned, ethnic origin apparently exerts no noteworthy influence on skeletal maturation. The progress of ossification depends primarily on a population's socio-economic status. Relatively low socio-economic status delays development and is likely to result in an underestimation of a person's age. Use of standard reference studies when examining members of socio-economically less developed populations does not, however, put the person concerned at a disadvantage in terms of criminal law—quite the reverse [11].

Given the scarce amount of data available, further research on the influence of ethnicity on eruption and mineralisation of third molars is needed.

References

[1] B.K.B. Berkowitz, T.P. Bass, Eruption rates of human upper third molars, J. Dent. Res. 55 (1976) 460–464.

[2] A. Demirjian, H. Goldstein, J.M. Tanner, A new system of dental age assessment, Hum. Biol. 45 (1973) 221–227.
[3] G. Geserick, A. Schmeling, Übersicht zum gegenwärtigen Stand der Altersschätzung Lebender im deutschsprachigen Raum, in: M. Oehmichen, G. Geserick (Eds.), Osteologische Identifikation und Altersschätzung, Schmidt-Römhild, Lübeck, 2001, pp. 255–261.
[4] W.W. Greulich, S.I. Pyle, Radiographic atlas of skeletal development of the hand and wrist, Stanford University Press, Stanford, California, 1959.
[5] H. Jung, Strahlenrisiken durch Röntgenuntersuchungen zur Altersschätzung im Strafverfahren, Fortschr. Röntgenstr. 172 (2000) 553–556.
[6] H.J. Kaatsch, Juristische Aspekte der Altersschätzung, in: M. Oehmichen, G. Geserick (Eds.), Osteologische Identifikation und Altersschätzung, Schmidt-Römhild, Lübeck, 2001, pp. 243–254.
[7] K.-F. Kreitner, F. Schweden, H.H. Schild, T. Riepert, B. Nafe, Die computertomographisch bestimmte Ausreifung der medialen Klavikulaepiphyse—eine additive Methode zur Altersbestimmung im Adoleszentenalter und in der dritten Lebensdekade? Fortschr. Röntgenstr. 166 (1997) 481–486.
[8] K.-F. Kreitner, F.J. Schweden, T. Riepert, B. Nafe, M. Thelen, Bone age determination based on the study of the medial extremity of the clavicle, Eur. Radiol. 8 (1998) 1116–1122.
[9] H.R. Müller, Eine Studie über die Inkonstanz des dritten Molaren (Fehlen, Anlage, Durchbruch), Med Diss, Dresden, 1983.
[10] A.F. Roche, W.C. Chumlea, D. Thissen, Assessing the Skeletal Maturity of the Hand-Wrist: Fels Method, C.C. Thomas, Springfield, 1988.
[11] A. Schmeling, W. Reisinger, D. Loreck, K. Vendura, W. Markus, G. Geserick, Effects of ethnicity on skeletal maturation—consequences for forensic age estimations, Int. J. Legal. Med. 113 (2000) 253–258.
[12] A. Schmeling, W. Reisinger, D. Wormanns, G. Geserick, Strahlenexposition bei Röntgenuntersuchungen zur forensischen Altersschätzung Lebender, Rechtsmedizin 10 (2000) 135–137.
[13] A. Schmeling, H.-J. Kaatsch, B. Marré, W. Reisinger, T. Riepert, S. Ritz-Timme, F.W. Rösing, K. Rötzscher, G. Geserick, Empfehlungen für die Altersdiagnostik bei Lebenden im Strafverfahren, Rechtsmedizin 11 (2001) 1–3.
[14] A. Schmeling, A. Olze, W. Reisinger, G. Geserick, Age estimation of living people undergoing criminal proceedings, Lancet 358 (2001) 89–90.
[15] A. Schmeling, R. Schulz, W. Reisinger, M. Mühler, K.-D. Wernecke, G. Geserick, Studies of the time frame for ossification of medial clavicular epiphyseal cartilage in conventional radiography, Int. J. Legal Med. 118 (2004) 5–8.
[16] J.M. Tanner, Growth at Adolescence, Blackwell Scientific Publications, Oxford, 1962.
[17] J.M. Tanner, R.H. Whitehouse, W.A. Marshall, M.J.R. Healy, H. Goldstein, Assessment of Skeletal Maturity and Prediction of Adult Height (TW2 Method), Academic Press, London, New York, San Francisco, 1975.
[18] J.M. Tanner, M.J.R. Healy, H. Goldstein, N. Cameron, Assessment of Skeletal Maturity and Prediction of Adult Height (TW3 Method), W.B. Saunders, London, 2001.
[19] H.-H. Thiemann, I. Nitz, Röntgenatlas der normalen Hand im Kindesalter, Thieme, Leipzig, Stuttgart, New York, 1991.